BIOLOGICAL OBSERVATIONS ON *PHASIA ROBERTSONII* (TOWNSEND) (DIPTERA: TACHINIDAE), A NATIVE PARASITE OF ADULT PLANT BUGS (HEMIPTERA: MIRIDAE) FEEDING ON ALFALFA AND GRASSES

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Abstract.—*Phasia* larvae were found only in the adult stage of the mirid species examined. Only one species of *Phasia* was detected, *P. robertsonii* Townsend); this species has been known by several other names, but most publications refer to it as *Alophorella aeneoventris* (Williston). *P. robertsonii* was reared from six species of mirids (ranked by parasitism level): *Leptopterna dolabrata* (L.) (1.8%), *Lygus lineolaris* (Palisot) (0.6%), *Megaloceroea recticornis* (Geoffroy) (0.4%), *Stenotus binotatus* (F.) (0.2%), *Trigonotylus coelestialium* (Kirkaldy) (0.2%), and *Adelphocoris lineolatus* (Goeze) (0.1%). Five of these host records have not been reported before, and represent a wide variety of hosts—grass and legume feeders, univoltine to polyvoltine species, and immigrant as well as native mirids. The significance of this broad host range is discussed, including its relation to the low parasitism rates observed in this study and others. *P. robertsonii* had two generations per year in northwestern New Jersey, the first mainly in June and mostly on grass-feeding mirids, and the second exclusively on *Lygus* in October. No pupal diapause was detected, but parasite larvae may overwinter inside *Lygus* adults. The very low parasitism rates indicate that tachinids provide little or no population suppression of the six mirid species studied.

A multi-year field study of the parasites of mirid pests of alfalfa (Day et al., 1990, 1992) has shown that there are three kinds of parasites found in adult mirids—nematodes, braconids (Hymenoptera), and tachinids (Day, 1987). The braconids (*Peristenus* and *Leiophron* spp.) are much more abundant than the others, but braconids result from oviposition in mirid nymphs rather than in adults (Loan, 1974), and their presence in adults appears to be the result of poor synchrony (Day, unpubl.). It is not known if nematodes parasitize adult mirids, or whether the small percentages found in adults are, like the braconids, carryovers from the nymphal stage. On the other hand, tachinid larvae are found only in mirid adults (Day, unpubl.), so are an obligate parasite of this stage. Unfortunately, the literature contains almost nothing on the host range, degree of parasitism, and life cycles of tachinid parasites of mirids.

In addition, it appears that there are fundamental differences between the host relationships of the tachinids and the braconids that parasitize mirids. This paper will provide information on these subjects, and hopefully will stimulate others to conduct further research on tachinid parasites.

MATERIALS AND METHODS

Field collections. Beating net samples (usually 100 sweeps, occasionally 50) were taken from each of three alfalfa fields in northwestern New Jersey (Blairstown area, Warren and Sussex Counties). Sampling was at weekly intervals in spring and early

summer, and biweekly in late summer and early fall. Data from 11 years (1980–1990) are reported in this paper.

Mirid adults and nymphs were aspirated into separate styrene vials, food plant tips were added for sustenance, and ventilated caps were applied. Vials were promptly placed in an insulated cooler with freeze-packs, to minimize mortality.

Laboratory procedures. The numbers and species of the mirids were verified the next day in the laboratory, and most were placed in rearing cages with food (aliquots were frozen, for later dissection, to determine the amount of parasitism). Plant stems in vials of water were added as needed (usually twice weekly)—grass seed heads were used for grass-feeding species, and alfalfa tips for alfalfa-feeding mirids.

The ventilated styrene "Loan" cages (Loan and Holdaway, 1961) had a "false" screened bottom, to allow parasite larvae to quickly move down to the vermiculite pupation medium, avoiding possible predation by the mirids. The vermiculite was dampened every 3–5 days, and after 11 days, was removed to a small, separate, parasite emergence cage. This procedure was repeated for a second 11-day period, to recover any late-emerging parasites. Each emergence cage was held in an environmental chamber (25°C ± 1½°, 16 L:8 D photoperiod, 65% RH ± 10%) for three weeks. Cages were then moved to an outdoor insectary for the summer and fall, then to a refrigerator (2°C) for winter. In early spring, cages were returned to the environmental chamber, for emergence of diapausing parasites. The latter step proved necessary for the braconid parasites, but all tachinids emerged during the initial three-week period, prior to moving samples to the insectary.

After all parasite emergence had ceased, the vermiculite was carefully examined for parasite cocoons and puparia, to determine if mortality had occurred (if so, parasitism data were adjusted). However, few puparia without exit holes were found, indicating that tachinid mortality was low.

RESULTS AND DISCUSSION

Tachinid species. A total of 54 adult tachinids were reared during an eleven-year period, from 11,651 adult mirids. Just over half of the flies were determined, and only one species was detected, *Phasia robertsonii* (Townsend). This tachinid has been known by several different names (as will be discussed later), but most publications refer to it as *Alophorella aeneoventris* (Williston) (e.g., Arnaud, 1978; Stone et al., 1965).

Mirid hosts. The tarnished plant bug, *Lygus lineolaris* (Palisot) produced more *P. robertsonii* (Table 1) than did the other mirids. It is notable that *robertsonii* was reared from all six mirid species, and that five of the ten host associations in Table 1 are "new" (not found in recent literature, nor in the compilations by Arnaud, 1978; Herting, 1971; or Thompson, 1950, 1951). No doubt this lack of information is a result of the low parasitism rates by *P. robertsonii* (as will be discussed later), which makes them harder to detect, and of the small number of workers researching the parasitism of mirids in the field.

Host range. The broad host range (Table 1: original data, plus information from Arnaud 1978 for the three *Phasia* spp. now regarded as synonymns (Sun Xuekui pers. comm.) of *P. robertsonii* [*P. aeneoventris, P. fumosa* (Coquillett) and *P. pulveria* (Coquillett)] includes eight mirid species, a spittlebug (Cercopidae), and a

Table 1.   Mirid hosts of *Phasia robertsonii* 1980–1990.

Hosts	Frequency[a]	New host record[b]
Lygus lineolaris (Palisot)	63%	
Leptopterna dolabrata (L.)	28%	+
Adelphocoris lineolatus (Goeze)	4%	+
Megaloceroea recticornis (Geoffroy)	2%	+
Stenotus binotatus (F.)	2%	+
Trigonotylus coelestialium (Kirkaldy)	2%	+

[a] Percentage of all parasites reared from each mirid host. This approximates the relative abundance in nature of *Phasia* from the different mirid species, and is a product of the number of each mirid collected (a result of the abundance and number of generations of each species) and the percentage parasitism (data in Table 2).

[b] Not previously reported in the literature. Additional hosts are recorded in Arnaud (1978) (parasite genus listed as *Alophorella*) for the following two species, which are now regarded as synonyms of *P. robertsonii* (Sun Xuekui: pers. corr.): *P. aeneoventris*: *Lygus hesperus* Knight (Miridae), *Cosmopepla bimaculata* (Thomas) (Pentatomidae), *Philaenus spumarius* (L.) (Cercopidae), and *P. fumosa*: *Lygocoris caryae* (Knight) (Miridae). I found four of the five reference sources given by Arnaud for these records (for all spp. except *L. caryae*) but only one provided incidence data (Clancy and Pierce, 1966: one tachinid from two years of collections of *L. hesperus*).

stinkbug (Pentatomidae). The six mirid hosts in the present study (Table 2) represent grass and legume feeders, univoltine and polyvoltine species, and immigrant as well as native origins. This "generalist" approach suggests that *P. robertsonii* is not likely to have a significant impact on any one species, as a "specialist" parasite might, and this is confirmed by the data in Table 2 (right column). The average parasitism of the most-preferred mirid, the meadow plant bug (*L. dolabrata*), was only 1.8%, hardly an indication of close adaptation, or "preference."

In a recent paper on British tachinids, Eggleton and Gaston (1992) pointed out that although tachinids are often thought of as dipteran equivalents of the endopar-

Table 2.   Mirid biologies, and parasitism by *P. robertsonii* 1980–1990.

Mirid species[a]	Native	Host plant	Gener./ yr.	No. reared Hosts	No. reared Para.	Mean parasitism[b]
1. *Leptopterna dolabrata* (L.)		grasses	1	832	15	1.80%
2. *Lygus lineolaris* (Palisot)	+	dicots	3	5,878	34	0.58%
3. *Megaloceroea recticornis* (Geoffroy)		grasses	1	242	1	0.41%
4. *Stenotus binotatus* (F.)		grasses	1	448	1	0.22%
5. *Trigonotylus coelestialium* (Kirkaldy)	+	grasses	3	466	1	0.21%
6. *Adelphocoris lineolatus* (Goeze)		legumes	3	3,785	2	0.05%
Totals				11,651	54	
Weighted average						0.46%

[a] Only the adult stage is parasitized by *Phasia*. A 7th species [*Halticus bractatus* (Say)] is occasionally numerous in alfalfa (Day and Saunders, 1990), but it is not listed here because no Diptera have been reared from it—probably because it is too small.

[b] Actual parasite impact is somewhat higher: peak rates are naturally larger than mean rates, and the rearing method underestimates parasite incidence (Day, 1994).

asitic ichneumonids (Hymenoptera), the tachinids usually have a much wider host range. They suggest that the breathing tube of tachinids allows this flexibility, because it reduces the need for immunity to host defensive blood cells, which can cover and thus suffocate hymenopterous parasites. Because these cells are likely to vary considerably from one host species to another, this physiological heterogeneity would make it very difficult for any single endoparasitic hymenopteran species to develop biochemical adaptations to many host species. Eggleton and Gaston reviewed host range data for 59 British tachinids, finding that 54% had five or more host species. It would be interesting to do a similar study on American tachinids— especially because Arnaud 1978 contains host data for nearly ten times more tachinid species (519).

Effects on mirids. The low parasitism rates in Table 2 indicate that *P. robertsonii* does not have a significant suppressive effect on any of the six mirid species, over all years. For comparison, parasitism of *L. lineolaris* nymphs by (mostly introduced) braconid parasites has ranged from 29% to 36% (Day et al., 1990).

Similar low rates of parasitism of mirid adults by tachinids have been reported by Medler (1961) in Wisconsin, Clancy and Pierce (1966) in California, Graham et al. (1986) in Arizona, and Sillings and Broersma (1974) in Indiana. Bilewiez-Pawinska (1977) did not report finding any tachinids in Polish mirids. A few have been found in France, by USDA European Parasite Laboratory personnel (unpubl. reports).

Life cycle and diapause. When the number of mirids parasitized by *P. robertsonii* that were collected each month were graphed (Fig. 1), several relationships became evident. There apparently were two generations per year, one in spring to early summer, and one in the fall. First generation parasites usually attacked the grass-feeding mirids, most of which are univoltine (probably to take advantage of the "flush" of grass growth that occurs in the spring). Although some overwintered (May and June) and first generation (July) tarnished plant bug adults were also attacked, the fall generation of *Phasia* parasitized the latter species exclusively.

All of the *Phasia* adults emerged from their puparia in the laboratory in the same year that they were collected. There was no evidence of a developmental pupal diapause, as is common in the braconid parasites of mirids when they are handled in the same way [hosts containing parasite eggs and larvae in various stages of development were collected from the field, then reared in the laboratory (Day et al., 1990, 1992)]. There are two possible means of overwintering: as soil temperatures drop in the fall, the development of *Phasia* puparia should slow, so most late fall puparia cannot complete their development and produce adult flies until soil temperatures warm in May. This is not as "fail-safe" as the obligatory overwintering diapause in the braconid parasites of mirids (which prevents emergence during warm winter periods) and might be another reason that tachinids are not abundant parasites of mirids. On the other hand, the broad host range of *P. robertsonii* allows use of many different plant bug species, so host-finding would rarely be a limiting factor. It is also possible that *Phasia* larvae may pass the winter inside one of their six host species (only *Lygus* overwinter in the adult stage), but the number of *Phasia* found in dissections of *Lygus* adults was too low to determine if this occurs (1 parasite larva found in 146 adults collected in May, and no parasites in 87 adults collected in October and November).
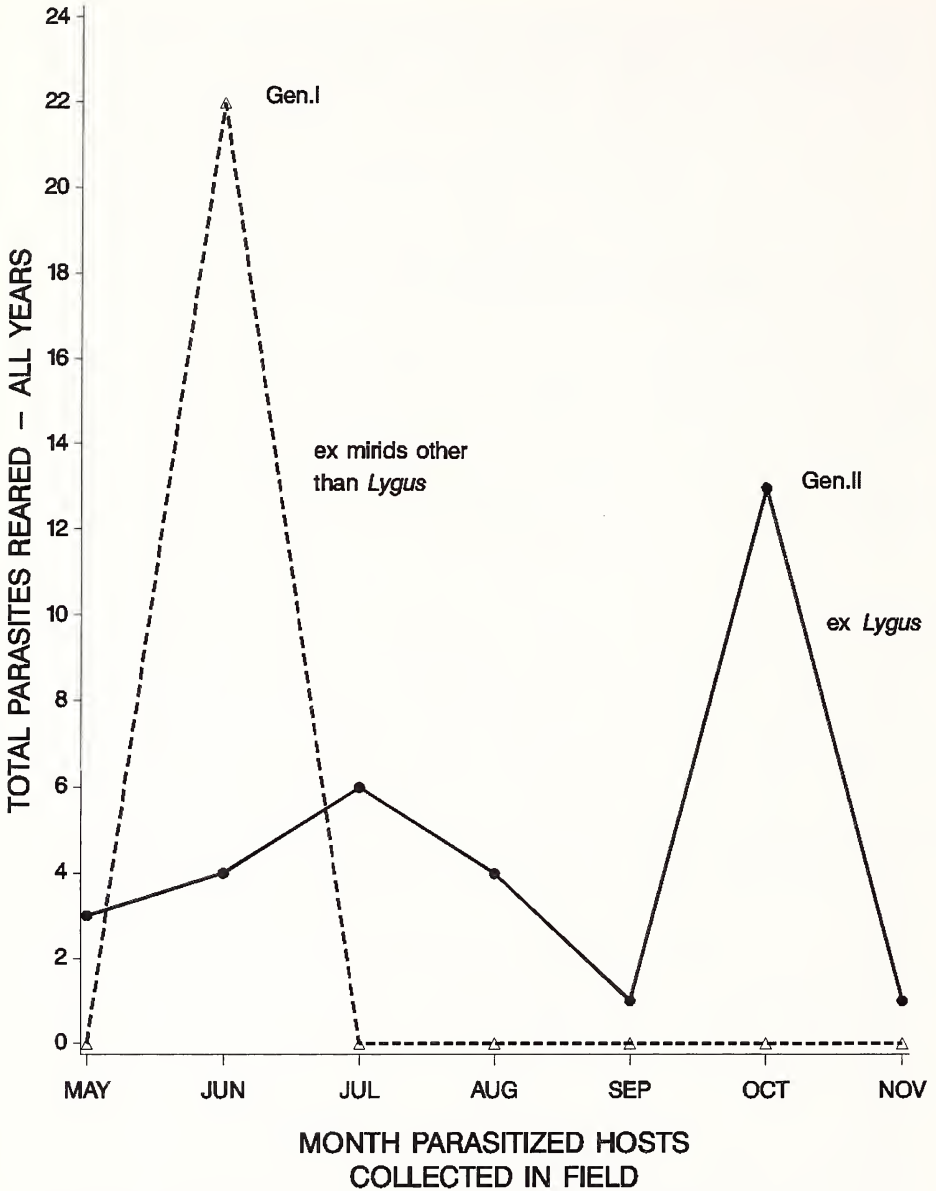
Fig. 1. Seasonal incidence of *P. robertsonii* reared from mirid adults, 1980–1990.

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